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Vortex Dynamics in High Reynolds number, Acoustically Forced, Reacting Wakes near the Global Stability Boundary BENJAMIN EMERSON, KELVIN MURPHY, TIM LIEUWEN, Georgia Institute of Technology —
This abstract discusses results from a set of PIV experiments involving longitudinally acoustically forced, bluff body stabilized flames. It is well known that wakes stabilizing high density ratio flames are convectively unstable and thus are more receptive to acoustic forcing, while low density ratio wakes are globally unstable and thus tend to oscillate at a global mode frequency. When the wake is forced near its natural frequency, its peak response may shift to (or towards) the forcing frequency, a phenomenon known as lock-in. These experiments show that the longitudinal forcing launches a pair of symmetrically shed vortices from the bluff body, in contrast with the wakes natural asymmetry. As the lock-in phenomenon is approached, the symmetrically stimulated vortices convect downstream initially in their varicose configuration, but then stagger until they are arranged in a sinuous configuration. The axial position at which this staggering occurs is a strong function of how close the forcing frequency is to the natural frequency, and the amplitude of the forcing. This effect is made evident by the spatial distribution of vortical fluctuations, by ensemble averaged vorticity contours, and by the cross spectrum of the fluid dynamics on either side of the flow centerline. This staggering process, and the position at which it occurs, has important implications on the thermoacoustics of bluff body stabilized flames, as it governs the dynamics of the heat release and its receptivity to acoustic forcing.

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